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NEW JAPANESE FUNGI

NOTES AND TRANSLATIONS—XII

TYÔZABURÔ TANAKA

GYMNOSPORANGIUM ASIATICUM Miyabe in Shokubutsugaku Zasshi (Bot. Mag.) Tôkyô, 17¹⁹²: 34. M. 36, ii, Feb., 1903 (nomen nudum); in Ideta's Nippon Shokubutsu Byôrigaku (Handb. Pl. Diseases in Japan) ed. 3, Tôkyô, Shôkwabô, M. 36, iv, Apr., 1903, 6. 214-217, fig. 50, 51 (nomen subnudum); Yamada in Ômori, J. & Yamada, G. Shokubutsu Byôrigaku (Plant Pathology) Tôkyô, Hakubunkwan, M. 37, ix, Sept., 1904, p. 303-306. (Japanese.)

Description by G. Yamada:

O. Pycnia epiphyllous on spots, first small, punctiform and orange-yellow, gregarious, few in number; pycnospores small, fusoid.

I. Aecia hypophyllous, on thickened, well-developed, brown spots having a beautiful, flavo-rubescens margin, very slender, 3-6 mm. high, cinereous; peridium tubular, not recurved in dehiscence, irregularly torn at the end, liberating reddish-brown aeciospores; aeciospores globose or sub-angular, minutely-verrucose, the pores several.

On *Pyrus sinensis* (Japanese sand-pear) and *Cydonia vulgaris*.

III. Telia foliicolous, forming reddish-brown, gelatinous masses, deep-fuscous when desiccated, pulvinate with sticky, orange-yellow teliospores; teliospores long-pediceled, orange-yellow, those produced on the outer part of the telium broad and short, thick-walled and deep colored, those formed in the inner part of the telium slender, thin-walled and light colored, readily germinating from the places near the septum; promycelia 1-2, rarely produced from the apex of the teliospore; sporidia 2-3 on a promycelium.

On *Juniperus chinensis* and *J. chinensis* var. *procumbens*.

The sporidia of III readily produce *Roestelia* (*R. koreaensis* P. Henn.) on Japanese pear leaves, according to the inoculation test conducted by Miyabe.

Ideta (under supervision of Miyabe) gives the spore characters as follows: "Teliospores 2-celled, fusoid, $45-70 \times 20-25 \mu$, long-pediceled." (*In* Nippon Shokubutsu Byôrigaku ed. 4, pt. 2: 470. M. 44, 1911. Japanese.)

Notes: Sydow first described *Gymnosporangium japonicum* from the specimens on the branch of *Juniperus chinensis* collected by Shirai at Komaba, Tôkyô (*in* Hedwigia, Beibl. 38³: (141) May-June, 1899), and later, Shirai succeeded in producing *Roestelia* (*R. koreaensis*) on Japanese pear leaves by inoculating with some mixed forms of *Gymnosporangium* found on the leaves and stems of *Juniperus chinensis*, and which he called *G. japonicum* (*in* Zeitsch. f. Pflkr. 10¹: 1-4, pls. 1-2. Apr., 1900). These results apparently induced many Japanese pathologists to believe that *G. japonicum* is the causal organism of the devastating Japanese pear-rust, though Miyabe clearly defines that *G. asiaticum* occurs only on the leaves. The first comprehensive description of *G. asiaticum* given by Yamada also limits the occurrence of the telia to the juniper leaf only, and Yoshino later showed that the pear-rust is caused only by the leaf-inhabiting form of *Gymnosporangium* (*G. asiaticum*) in the Kyûshû island, and not by the stem-inhabiting form which he never found existing in the island (*in* Shokubutsugaku Zasshi, Bot. Mag., Tôkyô, 19²²: 167-168. M. 38, vii, July, 1905. Japanese). Ideta also describes the telial stage from the leaf-inhabiting form only, though he was liberal in bringing the name *G. asiaticum* into the synonymy with *G. japonicum* in his latest description (l. c. ed. 4, pt. 2: 467, 469-470. 1911).

Despite the existence of the valid name *Gymnosporangium asiaticum* applied to the form on the juniper leaves, Sydow renamed the leaf-inhabiting form as *Gymnosporangium haraeum*, based upon the material collected by K. Hara from Mino province (*in* Ann. Mycol. 10⁴: 405. Aug., 1912). Using the fresh material taken from the juniper plant upon which Sydow's type was collected, Hara succeeded in producing pear-rust by inoculation (*in* Shokubutsugaku Zasshi 27³¹⁹: 348. T. 2, vii, July, 1913. Japanese). At the same time, Itô succeeded in producing rust on *Photinia villosa* by inoculating the stem-inhabiting form which he determined to be *G. japonicum* Syd. (*in* Shok. Zass. 27³²³: 221-

222. Nov., 1913). Itô concludes, therefore, that the leaf-inhabiting *Gymnosporangium* (*G. haraeaeum* = *G. asiaticum*) is the cause of the Japanese pear-rust (*Roestelia koreaensis*), while the stem-inhabiting form (*G. japonicum*) is connected with the *Photinia* rust (*Roestelia photinae* P. Henn.). (See l. c. p. 221, and also in Byôchû-gai Zasshi, Journ. Pl. Prot. 4³: 178-182. T. 6, iii, Mar., 1917. Japanese.) Jackson also succeeded in infecting sand-pear and quince with the teliospores from *Gymnosporangium koreaensis* Jacks. (= *G. asiaticum* = *G. haraeaeum*) and recommended *G. photinae* Kern (in Bull. N. Y. Bot. Gard. 7: 443. Oct., 1911) to supersede *G. japonicum*, following Itô's successful inoculation. (See Journ. Agr. Res. 5: 1006, 1007. Feb., 1916.) Dietel, on the other hand, made examination of aecia found on the leaves of *Cydonia vulgaris*, *Pirus sinensis* and *Pourthiaea villosa* (*Photinia villosa*) collected by Kusano at the Botanic Garden, Tôkyô, and brought altogether under one species *G. confusum* Plowr. (in Engler's Bot. Jahrb. 28³: 286, May, 1900), but Itô states that *G. confusum* never occurs in Japan, though Shirai lists it in his Nippon Kinrui Mokuroku (A list of Japanese fungi hitherto known, Tôkyô, Nippon Engei Kenkyûkai, M. 38, 1905, p. 39) and he also maintains that the first two must be identical with *G. asiaticum* and the third must be *G. japonicum* (in Byôchû-gai Zasshi 4³: 180. Mar., 1917).

In Korea, pear-rust was known quite early and its connection with juniper was suspected by the Korean agriculturist Soh You-Koh in his work *Haing po chi* written as early as about 1845. (Shirai, in Ann. Phytopath. Soc., Japan 1¹: 2. Jan., 1918.) In Japan, Hori first noticed the connection of the pear-rust with juniper *Gymnosporangium* in 1892, and he studied the actual damage of the pear plantation in Okayama first in 1900. (See Hori's Shokubutsu Byôgai Kôwa [Lectures on plant diseases] v. 2. Tôkyô, Seibidô, t. 5, xi, Nov., 1916, p. 301-302 [Japanese].) The infection of quince (*Cydonia vulgaris*) by the pear-rust fungus was reported by Miyabe and all later investigators, but Sydow made it a new species giving the name *Gymnosporangium spiniferum* to the aecial stage. (See Ann. Mycol. 10: 78. Feb., 1912.) Itô conceives this to be identical with *G. asiaticum* (l. c. p. 181), but

Kern brings this into the synonymy with *G. photinae* (in Mem. N. Y. Bot. Gard. 6: 246. Aug., 1916). Successful inoculation of *Cydonia japonica* by the pear *Gymnosporangium* was also reported by Yoshino (l. c. p. 168), Hori (l. c. p. 309) and Itô (l. c. p. 182). According to Yoshino (in Shok. Zass. 20²³²: 91. M. 39, v, May, 1906. Japanese), Ideta (l. c. ed. 4, p. 467) and Itô (l. c. 4⁸: 327), natural infection of European pear (*Pyrus communis*) is found but of slight extent, and Hori adds *Pyrus Toringo* and *Cydonia sinensis* as incidental hosts (in Hori's Nôsakumotsu Byôgaku, [Discourse on plant diseases], 7 impr. 1911. p. 292. Japanese). Ideta first reported that *G. asiaticum* occurs also on the leaves and stems of *Juniperus rigida* (in Shok. Zass. 18²¹¹: 157-158. M. 37, viii, Aug., 1904. Japanese), but later he corrected the statement in accordance with Miyabe's inoculation tests, that the leaf-inhabiting form only can produce aecia on pear leaves (l. c. 18²¹³: 223. Oct., 1904. Japanese). Later investigators all agreed with Ideta's final statement (see Hara, in Engei no Tomo [Friend of Hort.] 13⁹: 811-812. T. 6, ix, Sept., 1917. Japanese), except Itô who doubts these statements because only exceptional species can infect both the Sabina and Oxycedrus groups of juniper (in Byôchû-gai Zasshi 4³: 182-183). R. Nodzu even suggested that the pear-rust infects several species of *Chamaecyparis* (in Shimane Kenritsu Nôji Shikenjô T. 4 Nendo Gyômu Kôtei, [Ann. Rept. Simane Agr. Exp. Stat. for 1915]. p. 93. Japanese), but his suggestion received little credit by succeeding authors. Yoshino, on the other hand, succeeded in obtaining rust on *Cydonia vulgaris*, *C. japonica* and the Japanese pear by infecting with a *Gymnosporangium* found on the small stems of *Juniperus chinensis* in the Saga prefecture (in Shok. Zass. 20²³²: 91. May, 1906). He describes this stem-inhabiting telium as being "only swollen or expanded or globular, appearing quite different from the ordinary stem-inhabiting form which expands greatly with moisture into a tongue-like petal." This shows, according to Yoshino, that the telium of *G. asiaticum* occurs also on the small twigs of juniper in a form quite distinct from that of *G. japonicum*.

GYMNOSPORANGIUM YAMADAE Miyabe in Shokubutsugaku Zasshi (Bot. Mag.) Tôkyô, 17¹⁹²: 34-35. M. 36, ii, Feb., 1903 (nomen

nudum); Yamada in Ômori, J. & Yamada, G. *Shokubutsu Byôrigaku* (Plant Pathology) Tôkyô, Hakubunkwan, M. 37, 1904, p. 306-308, fig. 38 (Japanese).

Gymnosporangium Yamadaï Miyabe ex Ideta in *Nippon Shokubutsu Byôrigaku* (Handb. Pl. Diseases in Japan) ed. 3, Tôkyô, Shôkwabô, M. 36, iv, Apr., 1903 (nomen subnudum); Miyabe in Ideta ditto ed. 4, pt. 2: 471-474, fig. 174. M. 44, 1911 (Japanese).

Description by G. Yamada and K. Miyabe combined:

I. *Aecia* hypophyllous, on more or less thickened, reddish-brown spots, cylindrical, thick, 0.4-0.5 mm. in diam., 5-8 mm. high; peridium fulvous, splitting into a fine lace-like network; peridial cells narrow and elongated, 60-80 x 20-24 μ , inner wall smooth, outer wall slightly verrucose, side wall tuberculate with short papillae and never making elongated ridges; aeciospores subglobose or polygonal, 16-24 μ in diam., wall thick, brown, finely verrucose, the pores 8. scattered.

On *Pyrus Malus* (Apple), *Pyrus spectabilis*, and *P. Toringo*.

III. Telia caulicolous, from a perennial mycelium, appearing on reddish-brown, spheric swellings of the host stem, of somewhat shining appearance, disclosed by the rupturing of the cork in irregular fissures, flavo-rubescens, flat, petal- or tongue-shaped, irregular, deep-fuscous when desiccated; teliospores 2-celled, oblong, broad-ellipsoid, obovoid or clavate, upper cell always larger, frequently with thick-walled, obtuse papilla at the apex. 40-50 x 15-22 μ .

On *Juniperus chinensis* and *J. chinensis* var. *procumbens*.

Apple culture of the northeastern territories has been menaced by the disease. In Sapporo, Hokkaidô, it made its first appearance in 1902 with the introduction of *J. chinensis*, carrying the fungus from the south. According to Ideta (l. c. ed. 4 p. 472), Miyabe first found in 1904 the connection of apple rust with this particular *Gymnosporangium* inhabiting on the juniper stems. The aecial stage develops in July and August causing discoloration of apple leaves, which frequently results in defoliation. The telial stage appears on the juniper in April or May in the main island, and in May or June at Sapporo, Hokkaidô.

Illustrations: 4 text-figures by Yamada (l. c. p. 307) are given, showing telia on juniper branch, cross section on the swollen stem, teliospores and germination of teliospores.

Notes: The finding of aecia on *Pyrus spectabilis* by Shirai in Tōkyō was reported by Dietel as ? *Gymnosporangium claviaeforme* Jacq. (in *Hedwigia* 37: 216. July, 1898) and by P. Sydow as *Gymnosporangium* ? *clavariiforme* (Jacq.) Rees (do. *Beibl.* 37: (207) Nov.-Dec., 1898). P. Hennings listed an aecium on *Pyrus Toringo* collected by Shirai at Nikkō as ? *G. clavariiforme* (Jacq.) Rees (in *Engler's Bot. Jahrb.* 28: 262. Mar., 1900), and he later reported *G. clavariiforme* from Tōkyō, found by Hori on *P. spectabilis* (do. 31⁴⁻⁵: 732. Aug., 1902). These are all likely to represent *G. Yamadae*. Under *G. Yamadae* Miyabe sp. nov., Kern presented a description of the aecial stage found on *Pyrus spectabilis* by Nambu at Tōkyō (in *Bull. N. Y. Bot. Gard.* 7²⁶: 466. Oct., 1911), and Sydow later described the telial stage under the same name from material presented by M. Miura (in *Ann. Mycol.* 12: 159-160. Apr., 1914). Itō (in *Byōchū-gai Zasshi, Journ. Pl. Prot.* 4⁴: 244-245. Apr., 1917) ventured, however, to bring this name into the synonymy with *G. chinensis* Long (in *Journ. Agr. Res.* 1: 345. Jan., 1914) but all later investigators have considered the latter to be identical to *G. asiaticum* (= *G. haraeaeum* = *G. koreaeensis*). See Clinton, in *Ann. Rept. Conn. Agr. Exp. Stat.* for 1914 p. 15, 16. 1914; Jackson, in *Journ. Agr. Res.* 5: 1006. Feb., 1916 and Kern in *Mem. N. Y. Bot. Gard.* 6: 247-249. Aug., 1916.

GYMNOSPORANGIUM IDETA^E Yamada ex K. Hara in Hara's Kwaju Byōgairon (Discourse on fruit diseases) Irie-chō, Shidzuoka-ken, T. 5, xi, Nov., 1916. p. 95 (Japanese): in Shidzuoka-ken Nōkwaihô (Journ. Agr. Soc., Shidzuoka prefecture) no. 287: 51-52. T. 10, ix, Sept., 1921 (Japanese).

Description from Hara's second article:

O. Pycnia epiphyllous, immersed, on orbicular or irregularly-orbicular orange-yellow spots of 5-15 mm. broad, which later turn into beautiful reddish-brown color, globose, with pointed apex; pycnospores fusoid, exude with mucilaginous substance, 8-10 x 3-3.5 μ .

I. Aecia gregarious, protruding from the host tissue, often with common base, cylindrical, grayish-yellow, with apex first rounded, later lacerating, 1-3 x 0.3-0.6 mm.; aeciospores broad-ellipsoid, globose or subangular, grayish-brown, verrucose, 18-28 μ in diam.

On *Amelanchier asiatica*, collected by Hara in Kawaue-mura, prov. Mino (Gifu-ken).

Description from Hara's first article:

III. Telia caulicolous, formed on fusoid swellings, roughened at first, later lacerate, exposed as purplish-brown masses; teliospores cylindric-clavate or rarely subfusoid, 1-septate, upper cell being broader and shorter, 45-75 x 15-20 μ , wall 1.5 μ thick, the pores 2 in both upper and lower cells near the septum, or 1 apically in the upper and 2 in the lower cell, germinating mostly from the apical pore; sporidia ellipsoid, ovoid or globose, 12-15 x 7-10 μ .

On *Juniperus rigida*.

Revised description of III in the second article of Hara:

"Telial masses chestnut-brown or purplish-brown, at first hemispheric, later becoming flat by union, or liquify, varying in size, smallest about 5 mm. in diam., largest several inches broad, occasionally surrounding the twig; teliospores 2-celled, rarely 1- or 3-celled; 2-celled spores with thick, colored wall, ellipsoid, broad-ellipsoid, subfusoid or ovoid, the cells equal in shape but lower cell being a little longer and narrower than the upper, upper cell occasionally papillate, not constricted or slightly constricted, both ends rounded or narrowed, 35-50 x 20-25 μ , those round ones measuring 28-33 x 18-28 μ , wall 1.5 μ thick, the pores 2 or 1, mostly one apical in the upper cell, two lateral near the septum in the lower cell; colorless spores ellipsoid, cylindrical or fusoid, the cells unequal, upper cell larger and flatter, lower cell cylindrical or tapering toward the pedicel, 50-55 x 16-23 μ , wall 1 μ thick, the pores one apical in the upper cell, or two near the septum as in the lower cell; 3-celled spores elongated, contents brown or yellow-rust color, 1-nucleate, 65-75 x 18-20 μ ; pedicels cylindrical, very long, hyaline, 3-5 μ thick; promycelia clavate or cylindrical, 3-septate; sterigmata 3-4; sporidia ellipsoid ovoid or reniform, 10-15 x 7-10 μ ."

Related to *G. Miyabei* Yamada & Miyake much closer than to *G. japonicum* Syd. Inoculations by Yamada and by Hara, conducted independently, resulted in the formation of aecia on *Amelanchier asiatica*.

Notes: The telial stage found on *Juniperus rigida* was first identified as *G. tremelloides* Hart. (Hara in Shok. Zass. 27³¹³:

67. T. 2, i, Jan., 1913. Japanese). This identification was made by Sydow according to Hara's second report (l. c. 27³¹⁹: 348. T. 2, vii, July, 1913. Japanese), but as he had formerly succeeded in inoculating *Amelanchier* he considered this to be identical, at least partly, to *G. juniperinum* mentioned by Shirai in his "List" p. 39. Hara later obtained materials from Yamada who proposed the present scientific name according to the results of his inoculation. See Engei no Tomo (Friend of Hort.) 13⁹: 812. T. 6, ix, Sept., 1917 (Japanese).

The present species was later acknowledged by Itô as a distinct species, differing from *G. clavariiforme* by having much flatter telia; from *G. amelanchieris* in the elongated shape of the teliospores; and from *G. clavipes* in the different shape of the pedicel of the teliospores. See Byôchû-gai Zasshi (Journ. Pl. Prot.) 4⁵: 325-326. T. 6, v, May, 1917 (Japanese).

Hara's descriptions are based upon the specimens collected at Kawauye-mura, Mino province (Gifu-ken) (O. I. III.); various localities in Tôtômi province (Shidzuoka-ken) as Sakabe, Makinohara, Kasuisai, and Mikatagahara (III.).

Illustrations: Fig. 11, no. 6 in Hara's Kwaju Byôgairon shows 2 germinating teliospores and 2 sporidia.

GYMNOSPORANGIUM HEMISPHAERICUM K. Hara sp. nov. in Engei no Tomo (Friend of Hort.) 13⁹: 813. T. 6, ix, Sept., 1917 (nomen nudum); in Dainippon Sanrin Kwaihô (Journ. Forest. Soc., Japan) no. 419: 16-18. T. 6, x, Oct., 1917. (Japanese.)

O. Pycnia epiphyllous, on orbicular orange-yellow spots, gregarious, first immersed, later piercing the epidermis with ostiola erumpent, globose or depressed-globose, 125-170 μ in diam., ostiolar filaments hyaline, resembling pedicels of pycnospores; pycnospores fusoid or ellipsoid, hyaline, 10-13 x 2.5-3 μ ; pedicels filiform, 50-80 x 1-1.5 μ .

I. Aecia hypophyllous, cespitose or simply aggregate, conical or subcylindrical, delicate, brown, later cinereous or flavescent, 1-1.5 mm. high; peridium dehiscent only at the end; aeciospores globose or sub-angular, fulvous, verrucose, 20-28 x 18-25 μ .

On *Pyrus Zumi*.

Spots at first orange-yellow or yellowish-pink, orbicular, 1.5 mm. in diam., later enlarging attaining to 6 mm., becoming viscid and

then black-spotted on the upper surface, and producing hair-like aecia on the lower surface. At this stage, there develops a discolored area of pale-yellow or occasionally light-pinkish color around the spot.

III. Telia foliicolous or caulicolous, arising between scale-like leaves, oblate or hemispherical, fuscous or purplish-brown, later pulvinate, 1–5 mm. when desiccated, attaining to soy-bean size with moisture; teliospores subglobose, broad-ellipsoid or fusoid, rounded at both ends, sometimes papillate at the apex, occasionally with narrowed base, 2-celled, the cells almost equal-sized, constricted, $30\text{--}35 \times 25\text{--}30 \mu$, wall thin, $1\text{--}1.5 \mu$ thick, the pores 2 in each cell near the septum, or 1 apically in the upper, 2 in the lower cell; colorless spores fusoid or ellipsoid, commonly narrowed at both ends, 2-celled, each cell unequal, upper cell being $2\text{--}4 \mu$ shorter than the lower, slightly or not constricted, $30\text{--}37 \times 17\text{--}25 \mu$, wall thin, 1μ thick, the pores 1 apical or 1–2 lateral in the upper, and 1–2 lateral in the lower cell, lateral pores being located near the septum; 1-celled teliospores ellipsoid or ovoid, rounded at both ends, or papillate at the apex, wall colored, $1\text{--}2 \mu$ thick, the pores apical or lateral; pedicels cylindrical, long, $3\text{--}4.5 \mu$ thick; promycelia cylindrical or elongated like hyphae, curved, 3-septate, $10\text{--}12 \mu$ in diam.; sterigmata 3–4 on a promycelium, cylindrical, $5\text{--}6 \mu$ long; sporidia ellipsoid or ovoid, $10\text{--}13 \times 9\text{--}10 \mu$.

On *Juniperus chinensis*.

Type locality: Mino province (Gifu-ken) Kawaue-mura, Mar., 1917 (K. Hara).

The telia received a preliminary identification as *G. haraeaeum* by T. Hemmi and S. Itô, but after examining well-developed teliospores Hara became aware of its great difference from common pear-rust *Gymnosporangium* and thought it to be a new form. The inoculation was then carried out and he obtained positive results on *P. Zumi*, and negative on *P. Malus*, *P. Toringo* and *P. sinensis*. Hara also collected aecia from naturally infected *P. Zumi* in August, 1916.

Hara observed, on the other hand, a type of sorus arising from the space between the scaly leaves of juniper, in this respect similar to a telium. This form, becoming globose or hemispheric in shape, is much lighter in color than the telium, being brown or rust-colored, pulvinate, composed of numerous spores arranged in

chains on the pedicel $3-4.5\ \mu$ thick (sometimes attaining to $9\ \mu$ thick in absorbing moisture). The spores are globose or broad-ellipsoid, $20-26\ \mu$ in diam., wall is thick, dark brown, $1.5-2\ \mu$ thick, contents being granular, rust-colored. In cutting the sori longitudinally, well-developed hyphae were observed, which were either apparently filling the enlarged host cells or running between them. The hyphae were colorless or fulvous, branching, $2-2.5\ \mu$ in diam. The spores did not germinate after several attempts, and that led Hara to consider these to be rudimentary urediniospores which had probably lost their function. He states that these peculiar spores occur also in the telia without forming independent sori of their own. He also ventures to add an account of this form to the generic character of *Gymnosporangium*. See Byôchû-gai Zasshi (Journ. Pl. Prot.) 6^o: 754-755. T. 8, ix, Sept., 1919. (Japanese.)

GYMNOSPORANGIUM SHIRAIANUM K. Hara sp. nov. in Byôchû-gai Zasshi (Journ. Pl. Prot.) 6⁸: 681-687, 6⁹: 751-756. 1 pl. T. 8, viii-ix, Aug.-Sept., 1919. (Japanese.)

O. Pycnia epiphyllous, on orange-red or reddish spots of 5-10 mm. broad, immersed, globose or depressed-globose, $150-200\ \mu$ in diam., ostiolar filaments needle-shaped, narrowed at the apex, straight, containing orange-colored granules, $80-120 \times 3-4\ \mu$; pycnosporos cylindric or ellipsoid, narrowed at both ends, hyaline, $8-12 \times 3-4\ \mu$; pedicels linear, narrowed at the apex, hyaline, $15-30 \times 2.5-3\ \mu$.

I. Aecia hypophyllous, on 7-10-times thickened spots, the surface of which undulate, orange-yellow with margin of orange or reddish color, cespitose in small group or irregularly scattered, at first cinereous with purplish-yellow, simply projecting, later elongating into cylinder or tube, 0.25-0.5 mm. in diam., 1-5 mm. high; peridium straight or curved, at first with rounded end, later dehiscent; peridial cells sub-hexagonal, elongated, or fusoid, rarely subglobose, lower ones much shorter and light-brown in color, $33-90 \times 20-40\ \mu$, outer wall parallel-striated, $4-7\ \mu$ thick; aeciospores globose, ovoid or polygonal, fulvous, $18-23 \times 16-18\ \mu$, wall verrucose, $1-2\ \mu$ thick, the pores 6-14, pedicel linear, variable in length, $4-5\ \mu$ in diam.

On *Pyrus sinensis*.

Type locality: Tôtômi province (Shidzuoka-ken) Mikatagahara, June 6, 1919 (K. Hara).

III. Telia foliicolous, epiphyllous, solitary or rarely 2-3 together, first subepidermal, later erumpent, minute, depressed-globose or oblate-ellipsoid, upper surface convex, purplish-brown or castaneous, lower surface more or less flat, light-brown or light-colored, looking as though attached to the substratum with pedicel-like body, 1-3 mm. in diam., 0.5-1 mm. high, becoming honey-color with moisture; teliospores broad-ellipsoid, fusoid or ovoid, rounded or narrowed at both ends, sometimes pointed at the apex, 2-celled (rarely 3- or 1-celled), usually equal-sized, sometimes upper cell being broader and shorter, lower just opposite, or rarely vice versa, constricted or not constricted, $30-50 \times 15-25 \mu$, wall castaneous, $1.5-2.5 \mu$, the pores 2 in each cell near the septum, or 1 apically in the upper, 2 laterally in the lower cell; colorless spores oblong short-cylindrical or fusoid, rounded or narrowed at both ends, 2-celled, the cells equal or unequal, upper being larger or just opposite, mostly not constricted but rarely much constricted, wall fulvous, 1μ thick, the pores mostly 1 apically in the upper, 2 laterally in the lower cell, or 2 in each cell near the septum; 3-celled spores clavate or oblong, not constricted at the septum or slightly constricted, $64-66 \times 15-18 \mu$; 1-celled spores globose, ovoid or ellipsoid, $22-25 \times 20-22 \mu$, round ones 22μ in diam., wall $2-2.5 \mu$ thick; pedicels cylindrical, very long, $4-9 \mu$ thick, hyaline; promycelia at first cylindrical, later occasionally elongate into hyphal form of $5-7 \mu$ thick, or simply curved, 3-celled and $5-8 \mu$ thick; sterigmata filiform, $15-20 \times 2-4 \mu$, terminated by sporidia; sporidia reniform or ellipsoid, orange-colored, $10-16 \times 5-9 \mu$.

On *Juniperus littoralis*.

Type locality: Tôtômi province (Shidzuoka-ken) Mikatagahara, Mar. 20, 1919 (K. Hara), Mar. 21, 1919 (K. Yoshida), Apr. 7, 1919 (Y. Watanabe).

Illustrations: 1 black-and-white plate giving 15 figures to show aecial form on Japanese pear leaf: section of a pycnium, its ostiolar filaments, pedicels of pycnosporangia, pycnosporangia, section of an aecium, peridial cells, formation of aeciospores, mature aeciospores, telia on leaves of *J. littoralis*, a swollen telium, colored teliospores, colorless teliospores, germination of teliospores and sporidia.

The appearance of the aecial stage is quite similar to that of *G. asiaticum*, except the aecia look more or less purplish in color.

Notes: Sand-pear culture in the Mikatagahara region was given up some time ago on account of the virulence of rust, though

no *Juniperus chinensis* was found in the vicinity. After careful examination, Hara found *J. littoralis* growing wild in the region, which carried telia looking quite different from those of *J. chinensis*. Inoculation, using type material collected by Watanabe, proved that this telial form infects *P. sinensis* very easily, but *P. aucuparia* (*Sorbus aucuparia*, *S. japonica*) remained free (l. c. 6°: 751-752). Hara also suggested that the case reported by Ideta, regarding the leaf-inhabiting form of *Gymnosporangium* on *J. rigida* as the pear-rust organism, is one of misidentification of the host, because *J. littoralis* is often mistaken for *J. rigida* (l. c. p. 753).

SYNOPSIS OF JAPANESE GYMNOSPORANGIUM SPECIES *

I. TELIA ON STEM, CAUSING HYPERTROPHY

1. Telia on spheric swelling of the stem of *Juniperus chinensis*, and *J. chinensis* var. *procumbens*; aecia on *Pyrus Malus*, *P. spectabilis* and *P. Toringo*; aeciospores chestnut-brown.

GYMNOSPORANGIUM YAMADAE Miyabe, ex Yamada 1904, and Ideta 1911 (*G. Yamadai* Miyabe).

Syn. *G. claviaeforme* Dietel, non Jacq.

G. clavariiforme Syd., P. Henn., non Rees.

G. chinensis Itô, non Long.

2. Telia on fusoid swelling of the stem of *Juniperus chinensis*, and *J. chinensis* var. *procumbens*; aecia on *Photinia villosa* (*P. laevis*); aeciospores yellowish-brown.

GYMNOSPORANGIUM JAPONICUM Syd. 1899.

Syn. *Roestelia photinae* P. Henn. in *Hedwigia* 33: 231, Aug., 1894. (Ex Itô, 1913.)

Roestelia pourthiaee Miyabe in *Shok. Zass. (Bot. Mag.) Tôkyô*, 17¹⁹²: 35. M. 36, ii, Feb., 1903 (Japanese). (Ex Itô, 1917.)

Aecidium pourthiaee Syd. in *Bull. Herb. Bois.* 1900, no. 4: 3. (Ex Itô, 1917.)

Gymnosporangium confusum Diet., non Plowr. in *Engl. Bot. Jahrb.* 28: 286. May, 1900 *pro parte*. (Ex Itô, 1917, p. 180.)

G. photinae Kern. 1911.

* In looking over this synopsis, Prof. Miyabe kindly made the following comments:

(1) The plant here called *Juniperus chinensis* var. *procumbens* should be *J. chinensis* var. *Sargentii*, since *J. procumbens*, according to E. H. Wilson, represents an entirely different plant.

(2) The plant here called *Juniperus littoralis* is better called *J. conferta*, in accordance with modern classification.

(3) The apple rust fungus probably had been existing in the prefecture of Aomori for centuries, where the wild crab apple is found common.

3. Telia on fusoid swelling of the stem of *Juniperus rigida*; aecia on *Amelanchier asiatica*; aeciospores chestnut-brown.

GYMNOSPORANGIUM IDETAЕ Yamada ex K. Hara, 1916, 1921.

Syn. *Gymnosporangium tremelloides* Syd., non Hartig. (Ex Hara.)

G. juniperinum Shirai pro parte, non Fries. (Ex Hara.)

4. Telia on fusoid swelling of the stem of *Chamaecyparis pisifera*, *Ch. pisifera* var. *plumosa*, and *Ch. pisifera* var. *squarrosa*; aecia on *Pyrus Miyabei* and *P. Aria* var. *kamaoensis*; aeciospores yellowish-brown.

GYMNOSPORANGIUM MIYABEI Yamada & Miyake in Shok. Zass. (Bot. Mag.)

Tôkyô, 22⁵³: 21-28. Feb., 1908.

Syn. *Roestelia solitaria* Miyabe in Shok. Zass. 17¹⁰²: 35 M. 36, ii, Feb., 1903. (Ex Yamada & Miyake.)

R. solenoides Diet. in Engl. Bot. Jahrb. 32: 631. June, 1903. (Ex Yamada & Miyake.)

Gymnosporangium solenoides Kern in Bull. N. Y. Bot. Gard. 7: 450. Oct., 1911.

II. TELIA ON LEAF OR ON GREEN STEM, NOT CAUSING HYPERTROPHY

5. Telia conic or spheric, on *Juniperus chinensis*, *J. chinensis* var. *procumbens*, and *J. rigida*; aecia on *Pyrus sinensis*, *Cydonia vulgaris*, *C. japonica*, and *Pyrus communis*; aeciospores yellowish-brown, 18-22 × 18-21 μ (P. Henn.).

GYMNOSPORANGIUM ASIATICUM Miyabe, ex Yamada, 1904.

Syn. *Roestelia koreaensis* P. Henn. in Monsunia 1: 5. 1900. (Ex Yamada.)

Gymnosporangium japonicum Shirai, non Syd. pro parte.

G. confusum Diet., non Plowr. pro parte. (Ex Itô, 1917.)

G. spiniferum Syd. (Ex Itô, 1917.)

G. haraeaeum Syd. 1912.

G. chinensis Long. (Ex Kern, Jackson).

G. koreaense Jacks. 1916.

6. Telia oblate or hemispheric, on *Juniperus chinensis*; aecia on *Pyrus Zumi*; aeciospores yellowish-brown, 20-28 × 18-25 μ (K. Hara).

GYMNOSPORANGIUM HEMISPHERICUM K. Hara. 1917.

7. Telia depressed-globose or oblate-ellipsoid, on *Juniperus littoralis*; aecia on *Pyrus sinensis*; aeciospores yellowish-brown, 18-23 × 16-18 μ (K. Hara).

GYMNOSPORANGIUM SHIRAIANUM K. Hara. 1919

UNDESCRIBED OR QUESTIONABLE SPECIES REPORTED FROM JAPAN

1. Telia on *Juniperus nipponica*; aecia on *Sorbus japonica* (*Pyrus aucuparia* var. *japonica*) and *S. sambucifolia* var. *pseudogracilis* (*P. aucuparia*).

GYMNOSPORANGIUM ALPINUM Yamada ex Hara in Byôchû-gai Zasshi (Journ. Pl. Prot.) 69: 754. T. 8, ix, Sept., 1919 (nomen nudum).

Syn. *Gymnosporangium juniperi* Itô, non Link, based upon Miyabe (1903) and Ideta (1911). In Byôchû-gai Zasshi 44: 246. T. 6, iv, Apr., 1917 (Japanese). (Ex Hara, l. c.)

G. juniperinum Miyabe, Shok. Zass. 17: (35), non Fries (Aecia only; on *Pyrus aucuparia*. 1903). Ideta; aecia on *Sorbus japonica*, telia on *Juniperus nana* (?) 1911. Also Yamada, 1904, p. 308; Shirai List ed. I, p. 39 pro parte.

2. Telia on unknown host, collected by Miyabe in Karafuto (Saghalien).
GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) Rees. Ex Ideta, 1911, p. 474-475.
(Collected by Miyabe in Karafuto on *Juniperus nana*, ex Hara, l. c.)
(Shirai, List ed. I, p. 39, *pro parte*. Aecia on *Sorbus* sp.: List ed. 2, p. 265, aecia on *Pyrus*.)
3. Telia on unknown host; aecia on *Photinia villosa*.
GYMNOSPORANGIUM BLASDALEANUM Kern, 1911 p. 438; 1916, p. 250.
Syn. *Aecidium pourthiaee* Syd. (Ex Kern.)
4. Host entirely unknown.
ROESTELIA CANCELLATA Reb. ex Matsumura, Shokubutsu Meikwan, Index Pl. Japon. vol. 1: 171. M. 37, ii, Feb., 1904; Shirai List ed. 1, p. 88
(*Gymnosporangium Sabinae* for the synonym).
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